Towards Real Time

National Geodetic Survey / NOS / NOAA

Silver Spring, MD

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CORS Users Forum
FT Worth, TX
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Main Concepts

- Modify CORS sites for real time data transmission
- GNSS receiver data
- Transmission via the Internet
- Standardized protocols and formats
- Not a navigation service!

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Framework for Real Time GNSS Networks

- Federal Network
  - 200 CORS sites
  - NDGPS, WAAS, NOAA, PBO sites
  - Stream GNSS data, not correctors
  - via NTRIP and tcp/ip protocol over the Internet,

- Regional and local Networks
  - Use Federal network to calibrate and/or enhance local networks

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CORS Site Modification

- Receiver modifications
  - Firmware
  - Multiple satellite systems
  - Data interval
- Communications / Network modifications
  - Routers
  - Increased bandwidth
  - Internet
- Software

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Network Design Issues

- What format?
- What stations?
- What software?
- What distance?
- What data rate?
- What latency?

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Data Distribution Formats

- RTCM-SC104
  - Versions – 2.0, 2.1, 2.2, 3.0
  - Type 1 Fixed GPS corrections (1 sec)
  - Type 3 GPS reference station parameters (10)
  - Type 16 GPS special message (30,60)
  - Type 18 RTK uncorrected carrier phases (1)
  - Type 19 RTK uncorrected pseudoranges (1)
  - Type 22 Extended station parameters (15)
  - Type 59 Proprietary messages (1)

Data Collection Formats

- Raw
  - Topcon/Javad Compact (1)
  - Ashtech MBEN (5) / PBEN (5) / SNAV
  - Thales ASCII
  - SP3 ASCII
  - Trimble RT17, concise
  - Leica LB2
  - RINEX
  - BINEX

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Communications

- Frame Relay – USCG, NDGPS CORS **
- Internet (FTP, rcp) – State DOT's, WAAS, university CORS.
- Satellite / Modem – Hawaii, PBO CORS
- NTRIP – RTK CORS **

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Software

- NTRIP - Networked Transport of RTCM via Internet Protocol (version 1.5)
- NTRIP is an RTCM standard
- Application-level protocol streaming Global Navigation Satellite System (GNSS) data over the Internet
- Based on hypertext transfer protocol (HTTP/1.1)
- Simultaneous connections from PC's, laptops, receivers to a broadcast host
- Streams data to stationary and mobile users

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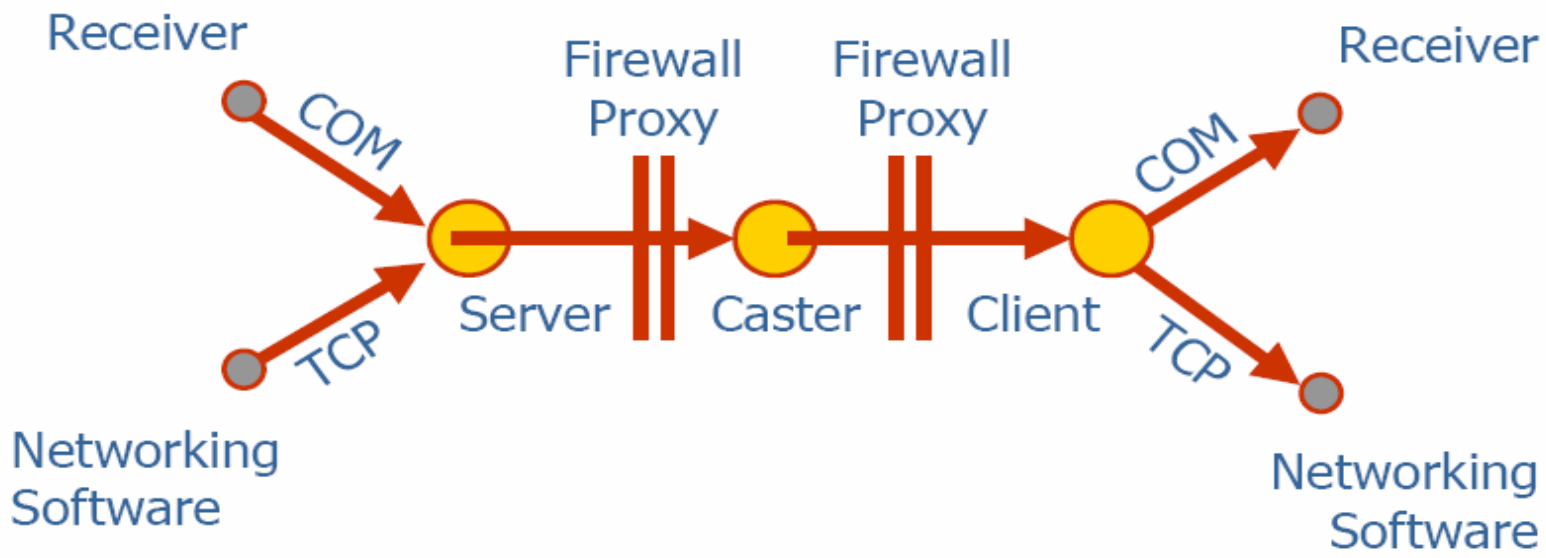
Internet Transport Configuration



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NTRIP

PROS

- RTCM standard
- Open documentation
- Software components developed under GNU General Public License
- Communications through a HTTP port

CONS

- Workload on server side
- Not supported by mobile IP provider

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Processing Considerations for Real Time

- Centralized Processing - NGS
  - Correction models
    - Ionospheric – dynamic or recent data
    - Tropospheric – dynamic or recent data
    - Satellite clocks
    - Multipath - from past data
  - Ambiguity resolution of reference station observables
  - Usually one communications channel
- Several processing locations
  - Many reference stations lead to many corrector streams
  - Several communications channels needed

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Positioning Limitations from Real Time Networks

- DGPS
  - L1 code corrections
  - Range 200 – 400 km
  - Meter level accuracy
  - Time delay – varies up to a few seconds
  - Continental coverage
- RTK – Single Base Station
  - L1 code, L1 / L2 carrier corrections
  - Range 10 to 15 km
  - Centimeter level accuracy
  - Time delay – typically less than a second
  - Regional and local coverage

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Post Processing Applications

- Post mission static positioning.
  - cm-level accuracy with a few hours of data, dm-level accuracy with one minute of data.
  - Solution delay - one hour.
- Post mission kinematic positioning.
  - dm-level accuracy for an aircraft, boat, or terrestrial vehicle.
  - Solution delay – more than one hour.
- Geophysics - crustal motion.
- Meteorology - water vapor in atmosphere.
- Space weather - free electrons in ionosphere.

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Real Time Applications

- Structural monitoring
- GIS – Rapid Response, 911
- Precision guidance – machines
- Meteorology - water vapor in atmosphere
- Space weather – ionosphere, troposphere
- Positioning – OPUS (rapid solution)
- Assist other real time applications - RTK

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PROPOSED POLICY FOR STREAMING GPS DATA VIA THE INTERNET

- NOAA's National Geodetic Survey is exploring the possibility of streaming GPS data (not correctors) from selected CORS via the Internet.
- These data will be publicly available and free of direct user fees.
- NGS is openly distributing these data to enable other organizations to provide location based services relative to the NSRS.

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PROPOSED POLICY

- Monitor the distribution of free electrons in the atmosphere.
- Monitor the distribution of precipitable water vapor in the atmosphere.
- Record the passage of seismic waves.
- While these GPS data may be applied to track the path of a moving platform--such as an aircraft, water vessel, or land vehicle–these data will not possess sufficient “integrity” to support a robust navigation service.

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NTRIP Installation at NGS

- NGS Broadcaster 140.90.112.133 2101
  - Converting NDGPS and other sites for NTRIP.
  - RTK messages.

- NTRIP Server
  - Modifications made to send receiver ID and password.

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Conclusion

- Streaming GNSS data over the Internet is feasible
- No significant lack of performance compared to other transportation media
- Advantages for user / service providers
- Developments for various products
- Promising solution for GIS
- Faster data access

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Questions / Comments

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